APPENDIX 1
Essential Fish Habitat Research by AFSC

Fish Habitat Assessment and Classification of Alaska Estuaries
Mitch Lorenz, Auke Bay Laboratory, NMFS
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NMFS Alaska Region (AKRO) is currently mapping coastal resources in Alaska to assist in the inventory, understanding and monitoring of nearshore marine resources. The ShoreZone method (Morris et al. 1995) of resource inventory in use by AKRO uses low speed aerial surveys to classify biological and geomorphic conditions along the coast and then links those classifications geospatially to a linear shoreline model through a GIS. That classification system has already been applied along the entire Washington state coast and throughout British Columbia. Our project focuses on resolving some of the technical and systematic issues with that inventory.

A technical deficiency of linear classification systems such as ShoreZone is an inability to reliably inventory resources in expansive areas such as estuaries and intertidal wetlands. In intertidal wetlands, for example, aerial classification units like those used in National Wetlands Inventory mapping (Cowardin et al. 1979) provide a much better inventory. The developers of the ShoreZone mapping system are aware of that issue and are working with us and other regional scientists to resolve it. In terms of resource management, a systematic problem with ShoreZone mapping is that it does little to relate functional values to the classifications. By developing a baseline inventory of estuarine resources that can be explored for correlations with ShoreZone classification data we hope to help resolve some of the aerial classification issues and also find ways to better associate functional values with ShoreZone classes.

To provide that baseline we are sampling at least 10 estuaries in each of six biogeographic strata in southeast Alaska. The strata are based on trends in biotic distribution noted by O'Clair and O'Clair (1998). The six strata generally divide southeast Alaska into northern and southern sections with divisions in each section for mainland coast, island, and outer coast strata. Estuaries within each stratum are selected to include a range of possible classification characteristics including exposure, watershed size and geomorphology, and adjacent land-use.

Twenty-five estuaries in southeast Alaska were sampled in 2005, bringing the total number sampled to 53. In addition, annual surveys are conducted in two additional estuaries to provide a time-series that is being used to assess temporal variability and habitat change. Sampling involves netting for fish and macroinvertebrates, vertically stratified water quality sampling, and foot surveys using ShoreZone field verification protocols. To date, sampling of three strata is complete and only one stratum has not been sampled at all. More than 200 animal taxa and more than 70 plant taxa have been identified. The identified taxa include more than ten percent of those in the RACE taxonomic database and many that are not in the Resource Assessment and Conservation Engineering (RACE) database.

Data on resource distribution and habitat use by life stage will be explored for correlations with ShoreZone classifications and other environmental variables such as salinity and turbidity. The majority of fish captured during estuary sampling are juvenile forage fish such as herring and sandlance, however juvenile salmon often dominate spring catches. Seasonal spawning aggregations of herring, sandlance, smelt, yellowfin sole, pricklebacks, cottids, and crab have been documented during the surveys. Shiner perch make up much of the summer catch in southern strata, but are nearly absent from northern strata and several northern range extensions have been documented for fish and invertebrate species. In protected bays, flatfish such as yellowfin sole and starry flounder are often abundant. Species diversity appears to be greatest in estuaries adjacent to large deep-water bays and least in those adjacent to fjords, however species assemblages in those two estuary types are generally very different. Distribution of marine algae, kelp, and eelgrass are dependant on environmental variables such as salinity, turbidity, and exposure.

Relationships between the distribution of marine resources and environmental variables will be used to help develop a classification system for estuaries that is compatible with ShoreZone inventories. Better understanding of the functional values of estuaries will improve resource inventories and also provide a template to help describe ecosystem functions for other habitat classifications.

Mapping and Monitoring Eelgrass Beds in the City and Borough of Juneau, Alaska.
Patricia Harris, Auke Bay Laboratory, NMFS
Last updated: November 2005

Project Need: Nearshore areas within the City and Borough of Juneau (CBJ), Alaska, continue to be under development pressure from shore-based facilities and intertidal projects. Since our 2004 field effort, a fish processing plant has become operational in Auke Bay within a few meters of a large eelgrass bed and another bed was subjected to a 61,000-68,000 liter diesel spill. Pending proposals would allow additional fill placed in these two eelgrass beds. These events highlight the need for continued assessment and monitoring of CBJ eelgrass beds to determine their value as fish habitat and the effects of development over time.

Eelgrass supports high fish diversity and abundance, and is especially important for juvenile fishes. Reductions in bed size and eelgrass biomass have occurred in other locations due to increased nutrient loads from outfalls, increased sedimentation, and increased propeller or anchor scour.

Research Objectives: Measurements of eelgrass bed size and fish use in 2005 will be added to a *ShoreZone* GIS database so that the changes over time can be tracked. Eelgrass disturbance can result from climate change or local development impacts. This study will serve a NOAA strategic goal: to protect, restore, and manage the use of coastal and ocean resources by increasing understanding of ecosystems through mapping and characterization of coastal areas.

Progress in 2004 and 2005: In the first two years of this project, we mapped 17 eelgrass beds with GPS, and determined plant density, biomass, percent cover, and canopy height in 7 beds. Eelgrass sampling occurred in late June through late August. Thermographs recorded seawater temperatures in two beds where development has occurred or will soon occur, and in two beds that may not experience development for some years. Eleven eelgrass beds were sampled for fish and marcroinvertebrates with a beach seine from late June through late July.

Eelgrass: Preliminary data analysis indicates high variability among eelgrass beds in area and biological parameters. Bed areas ranged from less than a square meter to 5.7 hectares; biomass (dry weight/ m^2) ranged from 1.1 to 306g/m^2; stem densities ranged from 32 to 1,408 stems/m^2; range of canopy heights was 150 to 1,000 mm, and percent cover ranged from 1 to 100%. Eelgrass was often patchy within a bed; approximately 10% of randomly chosen quadrats sampled were bare.

Fauna: A total of 28 fish species were caught at 11 seine sites. The most widely distributed species were crescent gunnel (*Pholis laeta*), tubesnout (*Aulorhynchus flavidus*), threespine stickleback (*Gasterosteus aculeatus*), and Pacific staghorn sculpin (*Leptocottus armatus*). Coho salmon (*Oncorhynchus kisutch*), chum salmon (*O. keta*), Starry flounder (*Platichthys stellatus*), bay pipefish (*Syngnathus leptorhynchus*), snake prickleback (*Lumpenus sagitta*), tubenose poacher (*Pallasina barbata aix*), frog sculpin (*Myoxocephalus stelleri*), silverspotted sculpin (*Blepsias cirrhosus*), and northern sculpin (*Icelinus borealis*) were found at more than half of the sites. Less widely distributed were Pacific herring (*Clupea pallasii*), Pacific sand lance (*Ammodytes hexapterus*), walleye pollock (*Theragra chalcogramma*), pink salmon (*O. gorbuscha*) and chinook salmon (*O. tshawytscha*). The most widely distributed invertebrates sampled were hermit crabs (*Pagurus* sp.) and unidentified juvenile shrimp (*Pandalus* and *Heptacarpus* spp.). Dungeness crab (*Cancer magister*) were captured at five sites.

A total of 5,313 fish were caught; the most abundant species were crescent gunnels (1,709), juvenile tubesnouts (1,490), and larval herring (989). Several hundred chum salmon, coho salmon, threespine stickleback, and staghorn sculpin were also caught.

Most fish caught were larvae or juveniles. Most notable was the large number of herring larvae caught at four sites. Similarly all Dungeness crab and shrimp caught were juveniles.

Products: This project will provide GIS maps and baseline data to the Alaska Regional Office (AKRO) NOAA Fisheries and other agencies, such as the CBJ. Data will also be available in a web-accessible GIS database maintained by AKRO that includes nearshore vegetation, geomorphology, and fish use. After three years of baseline data collection, a NOAA Technical Memorandum or a journal article will be published to analyze trends in area and physical characteristics of eelgrass beds and fish use.

Investigations of Skate Nurseries in the Eastern Bering Sea - Principal Investigator: Gerald R. Hoff, NMFS Alaska Fisheries Science Center, RACE Division, jerry.hoff@noaa.gov
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The goal of this study is to verify skate nurseries in the eastern Bering Sea, determine the temporal aspect of skate reproduction and skate embryo development, and to identify interaction of predatory species in the skate nurseries.

Bottom trawling was conducted at each of three sites to establish the species utilizing the area, egg spatial densities and extent of the nursery areas in July-August of 2004. The investigations identified three species specific nurseries including the Alaska skate *Bathyraja parmifera,* The Aleutian skate *B. aleutica*, and The Bering skate *B. interrupta.* Data collected at each site included skate egg developmental state, egg predation rate, egg densities and distribution, skate predation rate, and reproductive status of mature skates in the nursery.

The data collected to date verifies the location, extent, and species at three locations in the eastern Bering Sea. Each site is species specific and evidence suggests these sites are used for many years as nurseries. Each site will be sampled periodically throughout the year to track skate reproductive state and the development of the embryo population.

Atka mackerel natural history studies
Robert Lauth, Alaska Fisheries Science Center
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Atka mackerel (*Pleurogrammus monopterygius*) spawn demersally in rocky areas and nests comprised of egg clutches are defended by guardian males. Reproductively mature male Atka mackerel aggregate at specific nesting sites along the Alaskan continental shelf. Aggregations of nesting males, the developing embryos in the nests that males guard, and the nesting habitat itself are all vulnerable to the effects of bottom trawling. The potential impact of trawl fishing on Atka mackerel populations cannot be assessed without first understanding how the spatial and temporal aspects of their reproduction overlap with the commercial fishery.

The geographic distribution, depth range, and description of Atka mackerel nesting and spawning habitat were investigated in Alaskan waters from 1998 to 2004. Scuba diving and in situ towed underwater video cameras were used to locate and document Atka mackerel nesting sites and reproductive behavior. Results from this study extended the geographic range of nesting sites from the Kamchatka Peninsula to the Gulf of Alaska, and extended the lower depth limit for nesting and spawning from 32 m to 143 m. There was no apparent concentration of nesting sites in nearshore coastal areas as was surmised by other investigations. Nesting sites were widespread on the continental shelf across the Aleutian archipelago and into the western Gulf of Alaska. Nesting habitat invariably had rocky substrate and current, and water temperatures for nesting sites ranged from 3.9-10.5°C. Water temperatures within nesting sites varied little and did not appear to be limiting the upper or lower depth boundaries of nesting.

The temporality of the Atka mackerel spawning and nesting season in Alaska is currently being investigated using a towed video camera, time lapse camera, archival tags, and egg samples brought up in trawls. Using the time lapse camera and data from one archival tag, it was established that male Atka mackerel begin to aggregate at nesting sites in mid-June. In Kamchatka, Zolotov (1993) found that nesting started at the same time and spawning lasted until September. Gorbunova (1962) determined that the incubation for Atka mackerel eggs was 40-45 days; hence it was inferred that nesting season off Kamchatka lasted until early October.

Histological analysis of Atka mackerel ovaries by McDermott and Lowe (1997) and Cooper and McDermott (unpublished data) indicate spawning lasts through October in Alaskan waters, however, the ending time for nesting season remains unclear. As late as October, aggregations of nest guarding males were observed in Alaskan waters with a towed video camera, and egg masses were brought up in trawls tows done through a nesting site. No effort has been made later into the year to see if aggregations of males or egg masses are present in November and December.

Recent laboratory incubation experiments of fertilized eggs obtained from the field (Lauth, unpublished data) and from fish in captivity at the Alaska Sealife Center in Seward (Guthridge and Hillgruber, unpublished data) indicate that incubation of eggs lasts from about 1 to 3 months depending on temperature (at 10°C and 4°C, respectively). If eggs are being deposited in nests in October, it is likely that males are still guarding incubating eggs at nesting sites through November or December. The towed video camera will be used at a known nesting site near Dutch Harbor, Alaska, in late November or early December 2005 to see if aggregations of males are still guarding incubating eggs.

Other means besides histology and underwater video are being used to determine the end of the spawning and hatching periods. Incubation rates from laboratory experiments will be used to stage over 100 egg clutches brought up from trawl tows made through nesting sites. Eggs will be staged according to their embryological development. Historical temperature data from the areas near the nesting site where eggs were collected will be used to estimate the range of spawn and hatch dates for the egg samples.